AN INTEGRATED FRAMEWORK FOR THE IMPLEMENTATION OF SUSTAINABLE ROAD INFRASTRUCTURE PROJECTS IN DEVELOPING COUNTRIES

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ABSTRACT

With recent unprecedented environmental deterioration becoming more adverse worldwide, discussions by the international community for establishing an appropriate response policy against this menace has become more urgent. This has led the world to focus on a new sustainable development agenda tagged – Sustainable Development Goals (SDGs). A significant section of the SDGs focuses on sustainable infrastructure development. Therefore, the road infrastructure sector cannot be left out of the sustainability agenda since it forms a significant part of infrastructure development. Though there are a few sustainability interventions in road infrastructure development, they are limited and unclear. Therefore, the purpose of this research is to develop an integrated framework to guide the implementation of sustainable road infrastructure projects in developing countries. The study will adopt a mixed method approach. Face-to-face interviews on selected representatives of key stakeholders will be carried out to select and classify, confirm and prioritize a list of sustainability performance targets that will be identified through literature and past research. A Delphi technique through questionnaire survey will be used to explore the extent to which the sustainability criteria and indicators impact or influence on Sustainable road infrastructure project implementation in developing countries. Through the identification and integration of different perceptions and priority needs of the stakeholders, as well as key sustainability indicators and solutions for critical issues, a set of decision-making guidelines will be developed to promote and drive consistent sustainability deliverables in road infrastructure projects. The study is expected to provide an innovative and practical framework which will aid road infrastructure development stakeholders in the implementation of Sustainable Road Infrastructure projects.

Keywords: *Developing Countries; Infrastructure Development; Road Infrastructure; Sustainable Development;*

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INTRODUCTION

With recent unprecedented environmental deterioration becoming more adverse worldwide, discussions by the international community for establishing an appropriate response policy against this menace has become more urgent. This has led the world to focus on a new sustainable development (SD) agenda tagged – Sustainable Development Goals (SDGs). Following the UN conference on Sustainable Development (Rio + 20), in June 2012, UN member states have been working to create the SDGs. These goals were launched finally at the UN summit in New York in September, 2015. The purpose of the SDGs is to form the blueprint for development policy and funding for the next 15 years. The SDGs are made up of 17 goals that seek to address the most pressing sustainability challenges facing the world by 2030. Seven (7) out of the 17 newly developed SDGs focuses directly and indirectly on sustainable infrastructure development.

The developing world contributes less in terms of the total world's environmental destruction. For example, carbon emissions seems very low, especially compared to advanced nations like China and the USA who contributes 20.2% and 19.1%, respectively (Baer et al, 2007). However, developing countries are still developing and striving to soothe its domestic poverty with almost half of their population still under the official poverty line. The released UN publication: "Towards a Green Economy: Pathways to Sustainable Development and Poverty Eradication" and the SDGs elaborates on the participation of developing countries in contributing to these mitigation options. The UN documents on SD above takes note of the greater responsibility of industrialized countries to that of developing countries in protecting the environment, as they are putting much larger strain on natural resources and the environment.

High income countries consist of one sixth of the world population, but is responsible for two thirds of the world's GHG (Green House Gas) emissions into the atmosphere, but it is developing countries that will suffer the most from the effects of weather extremes (World Bank, 2010). These indicators question developing countries responsibility with regard to SD. Because of this, the crux of SD is questioned - which should come first, growth or green development? However, recent studies raise critical questions about the mutual exclusivity of ecological sustainability and poverty alleviation. The aforementioned issues and further work of Burgess et al (1997), also highlights this point by addressing social consequences and poverty eradication within the framework of sustainability. Extensive international literature elaborates on the need and importance of sustainability, but as reported by Swilling (2006), various social movements within the developed countries are also evident and contribute to the current greening of national policies. The further pressure received from international stakeholders also promotes this issue.

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On the above-mentioned issues, the question of whether SD is applicable should not be asked, but if the industry is equipped to implement SD. Within this questioning framework it is highlighted that, globally, the transportation sector is estimated to contribute to about 25% of carbon dioxide (CO2) emissions while as part of this sector, road transport contributes 80% (World Resources Institute, 2007).

Because of the said reasons and the new agenda for SD, every engineering discipline and sectors of society have to play a role to achieve the global position of being sustainable (Jarmin, 2008). Therefore, it becomes evident that within the sphere of civil engineering projects, regardless of their size, their design, build, operation, maintenance, and removal consider sustainability throughout its whole life cycle equally to be compliant to the said agenda. Indeed, it is foreseeable policies such as sustainable procurement, sustainability monitoring, and sustainability reporting using relevant criteria become increasingly stipulated by clients and key stakeholders (or may become mandatory within the near future) for the respective industries to win work and/or remain competitive (Oltean-Dumbrava, Watts, & Miah, 2014).

Dependable and safe road transport systems are central for sustainable economic development, which assists in poverty reduction, shared prosperity and a desirable quality of life in developing countries (Montgomery, Schirmer, & Hirsch, 2014). A significant section of the SDGs focuses on sustainable infrastructure development (SID). One of the targets of the SDGs is that by 2030, all countries should provide access to safe, affordable, accessible and sustainable transport systems including infrastructure for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons. Therefore, the road infrastructure sector cannot be left out of the sustainability agenda since it forms a significant part of infrastructure development. Besides, the various professionals in the transportation sector such as planners, engineers and environmental scientists worldwide recognize that roadway systems need to be more sustainable in light of finite natural resources, sensitive environmental conditions and limited economic resources (Montgomery, Schirmer, & Hirsch, 2014). Sustainability is not just environmental considerations associated with energy conservation and alternative energy generation; it is the inseparable integration of the environmental, community/society, economic and other attributes that need to be managed at the project level to be effective and successful.

There are significant benefits associated with sustainable road infrastructure projects (SRIP) including improved cost effectiveness, reduced material consumption, improved community quality of life, increased protection of finite environmental resources and improved

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consideration of a life cycle approach (Greenroads, 2011). Other potential related benefits can be enhanced innovation and improved knowledge transfer and capacity building. These, in turn, provide results to support an entity (e.g., transport agency) by developing or demonstrating implementation of its sustainability goals and policy/programs. One approach to help promote SRIP has been an effort to develop comprehensive sustainability rating systems for transportation infrastructure systems (e.g., Envision, CEEQUAL, INVEST, Green Roads, GreenLITES, etc.). However, embedding sustainability principles and best practices into road infrastructure projects in the developing world has been a challenge due to many unique aspects including changing or varying degrees of commitment and limited financial resources (Montgomery, Schirmer, & Hirsch, 2014). In addition, there is often a lack of understanding about sustainability concepts, how to address them given the regional specific characteristics or the lack of availability of more sustainable based products and technologies in these countries.

To implement SRIPs successfully, there is the need to identify the suitable criteria and indicators. According to Lim (2009), to measure sustainability of road infrastructure projects, criteria and indicators that can represent the sustainability of a development process are required. The sustainability criteria and indicators are also useful for monitoring and measuring the state of the environment by considering a manageable number of variables or characteristics (McLaren &Simonovic, 1999).

With the launch of the SDGs, it is incumbent on all sectors especially the built environment to play a critical role to achieve the global position of being sustainable. Therefore, the main motivation for this research stems for the need to achieve SID as targeted by the SDGs. Besides, since research on SRIP implementation in developing countries is rare, the study hopes to fill the gap in this area. Therefore, the inspiration behind this research is to determine how SRIPs could be implemented in developing countries.

This paper presents a proposed PhD research to develop an integrated framework for the implementation of sustainable road infrastructure projects in developing countries. The problem and the gap the research seek to address is discussed as well as the significance of the study. The varied conceptual interpretation of sustainable road infrastructure development as well as the various frameworks, criteria and indicators are also presented. The proposed methodology to conduct the research as well as its envisaged outcome is also discussed.

Problem Statement

Stakeholders (both private and public sectors), are under pressure to look for economically feasible, socially viable and environmentally accountable project outcomes or processes that

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will bring about sustainable road infrastructure development (SRID). This will require not only the adoption of sustainability principles during project conception, design and planning, and innovative use of technologies and products during construction, but also to evaluate results and to consider accountability during project delivery.

Even though, in an ideal sense, the principles of sustainability should drive infrastructure development, many stakeholders are involved in the process and this seems to complicate the matter. At any given road infrastructure development project, stakeholders have their own concerns, priorities and interests, resulting in different expectations in the project delivery. The professionals similarly face the task of understanding and deciphering strategic sustainability objectives into real action at project-specific levels (Ugwu & Haupt, 2007). This is extra hampered by different vested interests of project stakeholders and the multi-dimensional outlooks of sustainability, combined with a lack of well-thought-out decision-making method and information at various categorized levels in road infrastructure project development.

In addition, there is a lack of integrated research where different parties in the road infrastructure industry address each issue individually and independently of other issues to which it is linked (CIB and United Nations Environment Programme - International Environmental Technology Centre, 2002). Many of the efforts of past research and development, often seen as the vision provider for the industry, contemplated technical innovation on isolated issues that were applicable only within certain localities and concerned with immediate outcomes (Yang et al., 2005). This has resulted in gaps in SRID such as the gap caused by a failure to identify common priorities.

Decision-making for SRID, therefore, requires new approaches that can integrate and synthesise all the dimensions and different point of views, in an all-inclusive manner (Deakin et al., 2001; Mitchell, 1999). This process requires the application of a suitable operational framework, and an evaluation method or approach that can guide stakeholders through the decision-making processes for SRID. However, at the moment, such a structure for organizing the information required in decision-making is not yet available, or at least not agreed on by the different disciplines and fields of activities in the road infrastructure sector in Developing Countries. This lack of an agreed structure that will assist stakeholders achieve greater sustainability in road infrastructure development (RID) is a major concern (Brandon &Lombardi, 2005).
Thus far, much of the attention on sustainability has concentrated on buildings within the built environment (Huang & Yeh, 2008). Little has been done on infrastructure systems, such as transportation and utilities, which may extend over large geographic spaces, with much

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broader and more wide-ranging potential impacts (Dasgupta & Tam, 2005). This is mainly surprising, given the fact that road infrastructure constitute a large portion of built assets undertaken in the built environment (Lim, 2009).Specifically, RID, which often leads other types of infrastructure development, merits due attention. This is critical because road systems produce a mixture of impacts on the environment and nearby communities (Surahyo and El-Diraby, 2009). Road infrastructure projects often involve large land use, high-energy input and enormous resource consumption – all elements which may cause serious impacts to the environment and social dislocation. So, it is imperative to balance the constraints and develop a SRIP implementation framework that will mitigate the impact of road construction activities.

Literature in the field shows there do exist research initiatives attempting to develop infrastructure sustainability assessment indicators and tools (eg. CEEQUAL, 2008; Ugwu and Haupts, 2007; Ugwu et al., 2006; Mirza, 2006; Daguspta and Tam, 2005; Sahely et al., 2005; Brent and Labuschange, 2004; FIDIC, 2004; MOD, 2003), but they do not focus on a particular type of infrastructure such as roads. Even though there are existing Sustainable Roads Assessment Tools such as one developed by Australia's Victorian State Road Agency (VicRoads) in 2007, GREENROADS, Envision among others, the adoption of these tools is rather limited, new and unclear. Though focusing on assessing the end results, the assessment tools did not probe into identifying and addressing precise issues that impact on the gap between sustainability efforts and their real deliverables during project delivery – which are the crux of every sustainability initiative. This is also coupled with the fact that these tools are many with varied criteria and indicators.

In light of the above discussions, two research needs can be identified, in relation to the practice of SRIP development within the road infrastructure sector. First, given the lack of a uniform understanding, there is a need to explore how SRID is interpreted within the industry. Second, there is a need to explore how these interpretations can be synthesized and transformed into practice through project level implementation. This research therefore, tackles these two issues of interpretation and implementation of SRIP. As a result, the research is unique in scrutinising the above issues through both the strategic level and road infrastructure project level perspectives.

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Aim of the Study

The purpose of this research is to develop an integrated framework to guide the implementation of sustainable road infrastructure projects in developing countries. The study will examine suitable sustainability criteria and indicators which are the essential variables that have been measured in the majority of previous studies to develop SRIP implementation frameworks. The research seeks to ascertain and incorporate the different perceptions and priority needs of the stakeholders, and address the grave issues that impact on the gap between sustainability motivations and their actual realization at project level, in order to develop an integrated framework for the implementation of SRIPs. Precisely, the anticipated final outcome of this research aim to function as a management tool to encourage more methodical and combined approaches to decision-making in the implementation of sustainability strategies to accomplish deliverable goals during the course of the development and delivery process of road infrastructure projects.

Research Questions

Based on the research problem and aim of the study, a few research questions emerged as stated below:

RQ1 What is the extent of influence of sustainability criteria in road infrastructure projects?

RQ2 What is the extent to which the sustainable road infrastructure project implementation framework be developed to guide road projects in developing countries?

RQ3 What are the perceptions and motivations of various stakeholders about 'sustainability' in infrastructure development?

RO4 What critical factors and issues affect the implementation of sustainable road infrastructure projects?

RQ5 What are the existing sustainability assessment methods for infrastructure projects?

RQ6 What are the primary criteria and indicators used to assess sustainability in road infrastructure projects?

Research Objectives

To provide answers to the research questions and achieve the aim of the research, the following objectives are set to:

RO1 Find out current theories and literature on sustainable road infrastructure development and to identify the gaps that need consideration;

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RO2 Evaluate existing sustainability assessment methods for road infrastructure projects;

RO3 Identify theperceptionsandmotivationsofvariousstakeholdersabout'sustainability'in road infrastructure development;

RO4 Identify the critical factors and issues that affect the implementation of sustainable road infrastructure projects;

RO5 Identify the primary road sustainability criteria and indicators used to assess road infrastructure projects;

RO6 Develop an integrated framework for implementing sustainable road infrastructure projects; and

RO7 Determine the validity of the conceptualized integrated framework for sustainable road infrastructure projects

Significance of the Study

As road infrastructure projects involve large resources and mechanisms, achieving sustainability not only on economic scales, but also through environmental and social responsibility becomes a critical issue. Conversely, present efforts are often hampered by diverse interpretation of the sustainability agenda by the stakeholders involved. For that reason, sustainability deliverables at the project level are regularly not as transparent and measurable as promised in project briefs and designs (Lim, 2009).

Specifically, the expected outcome of this research will function as a management tool to encourage more systematic and combined approaches to decision-making in the implementation of sustainability strategies to accomplish deliverable goals during the development and delivery process of road infrastructure projects. It is also anticipated the proposed framework will promote consultation, collaboration and communication among all decision-makers involved in road infrastructure project delivery to accomplish dependable decision-making steps during the development life span, and thereby increase sustainability outcomes in a harmonious way.

This study also seeks to add to the existing body of knowledge about sustainable development for road infrastructure development. The data to be collected will be an asset to knowledge on issues pertaining to sustainable infrastructure projects, in particular roads and highways. The results will serve to encourage associated stakeholders involved in RID to consider sustainable principles, and to establish ways to turn these principles into "win-win" situations for all actors.

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Additionally, the potential economic and intangible long term benefits to the project stakeholders because of the sustainability initiatives are underscored. It will also contribute to developing a sustainable community in general.

Sustainable Road Infrastructure Development Concept and Constructs (Criteria)

Although research has been conducted in SRID implementation, no universally accepted SRID concepts and constructs presently exist. Actually, researchers have different ideas about SRID concept. The concept is still a subject of debate (Brandon, 2000), still a hazy and ambiguous concept (Ametepey & Aigbavboa, 2015; Brandon, 2000; Dovers & Handmer, 1993). So far, sustainability in infrastructure development has come to mean different things to different people ((Brandon, 2000; Pearce et al., 1989).

As with sustainable development, the term sustainable infrastructure development is a crosscutting matter and means different things to different people. The review of related works suggests multiple definitions exist (for example, Kibert 1994; Wyatt, 1994; DETR, 2000; Langston & Ding, 2001) and there is inconsistency in scope and context. For simplicity, sustainable infrastructure development is best described as the subdivision of sustainable development and its application to infrastructure development. Infrastructure development involves all planning, developing, producing, designing, modifying or maintaining the built environment and includes manufacturers and suppliers of materials, clients, contractors, consultants and end users of facilities (CRISP, 2000). Therefore, sustainable infrastructure development could be best described as a subset of sustainable development, which encircles matters such as tendering, site planning and organization, material selection, recycling, and waste minimization.

In most literature, a common definition of sustainable infrastructure development, 'the creation and responsible management of a healthy built environment based on prudent use of resources and ecological principles' (Kibert 1994) and a myriad of other definitions (e.g. Roodman & Lenssen, 1994, 1995) focused more on the environmental aspect of sustainability. Others, for example Wyatt (1994) stated that 'sustainable infrastructure development philosophy requires a 'cradle to grave' appraisal of project, which involves managing the serviceability of project during its life- time and eventual deconstruction' focus on the economic aspect of sustainability. Ceres (2012) defines Sustainable infrastructure development as designing, building, and operating of these structural elements in ways that do not lessen the social, economic and ecological processes required to maintain human equity, diversity, and the functionality of natural systems. The American Society of Civil Engineers (ASCE) also defines Sustainable infrastructure as a structure that provides

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environmental, economic and societal well-being, now and for the future. According to United States Environmental Protection Agency (USEPA) sustainable infrastructure consists of an array of products, technologies and practices that use natural systems (or engineered systems that mimic natural processes) to improve overall environmental quality and provide utility services. Sustainable infrastructure considers policies, approaches and investments that consistently provide effective systems over the long term with adequate operations, maintenance and replacement (USEPA).

Only a few of the existing definitions are comprehensive and capture the holism of the concept. A good example of this is, 'sustainable infrastructure development comprises several processes through which a profitable and competitive industry delivers built assets to improve quality of life and stakeholder satisfaction' (DETR, 2000).
The key issues that could be drawn from these numerous definitions in the existing work have been summarized below.

- Most concentrated on either the environmental or economic aspect of sustainability while a few recommend integrating the three dimensions of sustainability: environmental, social and economic.
- Embedded in those definitions that capture a holistic approach to the concept is the idea of economic profitability based on environmental integrity and social responsibility.
- Sustainable infrastructure development involves all phases of the construction activities, which are: (i) Pre-construction - planning, option and tender appraisal, design stage etc.; (ii) Construction - construction impact, supply chain management etc.; and (iii) Post construction - operation and maintenance to the eventual deconstruction and recycling of resources, to reduce the waste stream usually associated with demolition.
- Sustainable infrastructure development encapsulates issues such as whole life cycle, procurement, site planning, material selection and the use of recycling, and waste and energy minimization and so on.

Therefore, the SID concept covers a wider scope and considers different dimensions. In this study, Sustainable road infrastructure development could therefore be defined as follows:
Designing, building, operating, maintaining and deconstructing road structural elements in ways that balances the social, economic and ecological processes required to uphold human equity, diversity, and the functionality of natural systems.

Various authors have divergent views on SID and its basic elements or variables. Lim (2009) agreed that although sustainability is applicable in the infrastructure sector, there is a lack of

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agreement on the implementation process and lack of understanding of the criteria and indicators as well. Conversely, it should be noted that much research has been carried out in SID and its implementation. The literature review conducted revealed there has been extensive research (Assah Amiril et al., 2014; Montgomery et al., 2014; Krishna & Jun, 2011; Lim, 2009; CEEQUAL, 2008; Ugwu and Haupts, 2007; Ugwu et al., 2006; Mirza, 2006; Daguspta and Tam, 2005; FIDIC, 2004) on sustainability criteria and indicators (constructs) and are used to measure SID implementation. However, there are disagreement among the various identified criteria and indicators by individual researchers and institutions.

A study by Montgomery et al. (2014) in their research sought to develop a sustainability rating system for roads in developing countries. The study provided an extensive set of environmental road sustainability criteria. The authors grouped the sustainability criteria into 5 categories: quality of life; Project leadership; Natural world; Natural resource management and; resilience and greenhouse gas emissions. Literature also reveals that different frameworks have adopted similar criteria for sustainability under different title. Hence, for a successful implementation of SRIP, it is pressing that stakeholders integrate and build consensus on the right criteria and indicators and understand its implementation.
After careful study of previous studies, it has been found that various sustainability gurus in the infrastructure sector have different views about SRID, although some similarities can be found. It is established also in the literature there are frameworks and models for assessing and rating sustainability of infrastructure projects. These frameworks and models provide insights into the application of sustainability to infrastructure projects and give the researcher a better understanding of SRID and its constructs. Nonetheless, it was obvious there are disparities in the various sustainability frameworks and models. Besides, the frameworks have also failed to capture some factors affecting its implementation in developing countries.

Even though, the frameworks identified from literature are the most comprehensive and robust in nature but important constructs such as public participation and governance, climate change response, and stakeholder management were missing. A much more comprehensive and robust integrated framework for implementing Sustainable Road Infrastructure Projects will be developed by considering public participation and governance, climate change response, and stakeholder management. Using the existing frameworks reviewed, it becomes clear that most of the models were based on the three pillars of sustainale development (Economic, Social, and Environmental).

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Table 1: Sustainable Infrastructure Development framework comparison

No.	Framework	Criteria
1.	Proposed Framework for this study	Social and Cultural Sustainability; Economic Sustainability; Environmental Sustainability; Institutional Sustainability; Health & Safety; Project Management; Resource Utilisation and Management; Engineering Performance; Climate Change Response; Public participation and Governance; and Stakeholder management
2.	CEEQUAL – Civil Engineering and Environmental Quality Assessment and Award Scheme	Project Management; Land Use; Landscape; Ecology & Biodiversity; The Historic Environment; Energy and Carbon; Material Use; Waste Management; Transport; Effects on Neighbours; Relations with the Local Community and other Stakeholders
3.	FIDIC's Project Sustainability Management(PSM)Guidelines	Equity; Health; Human rights; Education; Housing; Security; Population; Culture; Integrity; Atmosphere; Land; Oceans, Seas & Coast; Fresh Water; Biodiversity; Economic Structure; Consumption& Product Patterns; Institutional Framework
4.	BE^{2}ST-In-Highways	Social Carbon saving; Life Cycle Cost; Traffic Noise; Hazardous waste; Water Consumption; waste reduction (including in-situ materials); waste reduction (including ex-situ materials); Energy Use; Greenhouse gas emissions
5.	**Envision^{TM}**	Climate; Natural World; Resource Allocation; Leadership; Quality of Life
6.	**Green Guide for Roads**	Mobility for All; Transportation Planning; Environmental Impact; Energy and Atmosphere; Materials and Resources; Community Impact; Innovation and Design
7.	GreenLITES	Innovation/Unlisted; Materials and Resources; Energy and Atmosphere; Water Quality; Sustainable Sites
8.	**GreenPave**	Pavement Technologies; Energy and Atmosphere; Materials and Resources; Innovation and Design
9.	Greenroads	Pavement Technologies; Materials and Resources;

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		Energy and Atmosphere; Construction Activities; Access and Equity; Environment and Water
10.	I – LAST	Materials; Lighting; Transportation; Water Quality; Environmental; Design; Planning
11.	INVEST	Operations and Maintenance; Project Development; Systems Planning
12.	Montgomery, Schirmer and Hirsch (2014)	Quality of life category; Project leadership; Natural world; Natural resource management; Resilience and greenhouse gas emissions
13.	Lim (2009)	Environmental; Economic; Social, Engineering; Community engagement; Relationship management; Project management; Institutional sustainability; Health and safety; Resource utilization and management
14.	Transport for New South Wales (2012)	Environmental category (GHG emissions, water, pollution control, noise management, resource management, waste management, material consumption and biodiversity); Social category; (stakeholders' relationship, communities/public acceptance and heritage conservation); Economic category (corporate sustainability).
15.	Assah Amiril et al (2014)	Environment; Economic; Social; Engineering/resource utilization; Project administration
16.	Ugwu & Haupt (2007)	Economy; Environment; Society; Resource Utilization; Health and Safety; Project Management/Administration
17.	Huang & Yeh (2008)	Ecology; Landscaping; Material; Waste Reduction; Water Conservation; Energy Conservation

Thus, the Sustainable road infrastructure project implementation framework in this study will consist of eleven (11) constructs.

Research Methodology

Different methods of investigation will be used in the research, which is a mix of quantitative and qualitative research designs usually referred to as mixed method design. These approaches will be used to answer research questions and meet the research objectives, as well as develop an integrated Sustainable road infrastructure Project implementation

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framework. The qualitative method will make use of structured (using an interview guide) interview. The findings from this section will help to refine the survey tool (structured questionnaire) for the study. Delphi technique will be used in this method. The Delphi technique will be used to resolve conflicting issues on Sustainable road infrastructure Project implementation in the study areas through consensus. In the Delphi study, data on the ratings on the impact of the factors that determine the sustainability of road infrastructure projects will be obtained from the panel of experts. Experts will be asked to complete the questionnaire and reach consensus on the rated likelihoods and severity of various Sustainable road infrastructure project implementation factors and management issues. The process will involve a three round iterative process with the main aim of getting experts to reach consensus on the questions that will be raised in the questionnaire. Experts will be encouraged to give reasons for their dissenting views. The Delphi technique will be used to explore the extent to which the main attribute, sub- attributes, sub-factors impact or influence on Sustainable road infrastructure project implementation in developing countries. A face-to-face administered questionnaire survey will be conducted among stakeholders in the road infrastructure development sector. Data from the questionnaire survey will be obtained from key actors in the road infrastructure sector such as the road agencies, contractors, consultants and professionals such as engineers, designers, environmentalists, planners etc.

Data obtained from the Delphi Study will be analysed using Microsoft Excel, and spreadsheet software. The output from the analysis will be mainly descriptive statistics such as means, medians, standard deviations and derivatives of these statistics. Data gathered by means of the questionnaire survey will be analyzed using Structural Equation Modeling (SEM) software Version 6.2, which will be used to assess the factor structure of the constructs. The conceptual variables will be tested as a prior using SEM of the questionnaire survey results. The SEM process will be undertaken as Exploratory Factor Analysis (EFA), and further Confirmatory Factor Analysis (CFA) of the prior framework for an integrated Sustainable road infrastructure Project implementation for Developing Countries.

The research objectives will be achieved through the following methods:
Research objectives RO1 and RO2 will be achieved through conducting a literature review on the subject in question. It is principally a theoretical understanding of the discussion on sustainable road infrastructure development and general sustainability theories. The objectives RO3, RO4 and RO5 will be achieved by conducting a Delphi Study and a questionnaire survey. Research objective RO6 will be achieved by drawing on the conclusions from the extensive literature review and the findings from the Delphi Study and questionnaire survey. The final objective RO7 will be achieved through conducting a field

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questionnaire survey and modeling of the results, using a structural equation model software known as EQations Software (EQS).

Delimitation of the Study

It should be distinguished at the outset of this research that sustainable transport and sustainable road infrastructure development are two different areas of studies, even though they could be related or possess similar sustainability objectives (such as minimizing environmental impacts). While sustainable transport looks for sustainable modes of mobility such as public transport systems (Hensher, 2007; Chamber, 2002), sustainable road infrastructure development mainly focuses on sustainable construction solutions at the project-level. Although sustainable modes of transport are the key to addressing major traffic problems, improving the efficiency and effectiveness of any system depends on both infrastructure and modes (Sohail et al., 2006). In this case, the focus of this research is on developing sustainable road infrastructure project implementation framework, without undermining the parallel importance of sustainable transport development. This study is delimited to the project execution phase of road infrastructure development in developing countries.

The research aim and objectives will be explored within key actors in the road infrastructure sector in Ghana. The key actors in this context refers to stakeholders such as Government Institutions mandated to manage the road infrastructure sector, Consultants, Contractors, Financiers, Academics, sustainability experts who play active role in the road infrastructure sector.

Envisage Outcomes/ Relevance to Knowledge

It is expected the study will contribute to the road infrastructure sector in developing countries. Several work has been done and continues to be done worldwide on SD practices and policies, even in the road infrastructure sector. This proposal is in response to a call on the road construction sector to develop measures to improve their sustainability practices, that is, curbing the impacts of road construction activities on the environment. The focus of the thesis is on developing an integrated framework for implementing sustainable road infrastructure projects. It is expected the framework will thus fill a theoretical gap in sustainable infrastructure literature on the road infrastructure sector to achieve its sustainability goal. It is also envisaged the research will contribute to existing literature on sustainable road infrastructure. Besides, the research is also expected to identify and propose areas in sustainable road construction which can be further investigated to additionally enhance to achieve the sustainability goal by the road infrastructure sector in developing countries and indeed globally.

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The research is also envisaged to make some practical contributions to industry. It is expected to provide an innovative and practical framework which will aid road infrastructure development professionals in implementing SRIP. The study is also expected to contribute to the industry by educating the various respondents who will take part in the study on SRIP.

Conclusion

Roads and road infrastructure will be faced with many challenges over the coming decades. These include the considerable number of rapidly expanding economies around the world, significant changes to weather patterns and extreme weather events, depleting natural resources and predicted increases in energy and resource prices. Leading efforts around the world are now showing how such challenges can now be met with creativity and innovation across many aspects of roads. The dominant message emerging from these efforts is the opportunity exists to transform the way road infrastructure is conceived and built, to aid society to respond to climate change and reduce a range of environmental pressures. Hence, this research seeks to develop an integrated framework for implementing sustainable road infrastructure projects in developing countries. It is expected the framework will therefore fill a theoretical gap in sustainable construction literature with respect to the road infrastructure sector to achieve its sustainability goal. In addition, the research is also expected to identify and propose areas in sustainable road construction which can be further investigated to additionally enhance achieving the sustainability goal by the road construction sector.

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